Explaining Stock Market Correlation:

A Gravity Model Approach

by

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A gravity model, frequently used to explain trade patterns, is used to explain stock market correlations. The main result of the trade literature is that geography matters for goods markets. Physical location and trading costs should be less of an issue in asset markets. However we find that geographical variables still matter when examining equity market linkages. In particular, the number of overlapping opening hours and sharing a common border tends to increase cross-country stock market correlation. These results may stem from asymmetrical information and investor sentiment, lending some empirical support for these explanations of the international diversification puzzle.

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1 INTRODUCTION

Geographical variables have enjoyed much empirical success in explaining market linkages. These variables have been applied in such diverse areas as trade flows, price differentials, migration flows and foreign direct investment flows. Here, we examine the question of whether geography also matters for asset markets. Asset markets are qualitatively different from other markets in the sense that trade is weightless – there is no physical movement of goods, capital equipment or people. Yet, if habit and convenience play a part in determining connections between goods markets, these factors, which we call 'psychological' geographical factors may also be important in financial asset markets.

The particular aspect of asset markets examined here is the correlation between returns in international equity markets. Portfolio selection models, and their success in real world applications, depend crucially on asset market correlations. In terms of risk reduction, the coefficient of correlation is the most important input into any asset allocation model. There are a number of accepted stylised facts regarding stock market co-movements. Firstly, correlations are generally lower between international than domestic markets. This has been the driving force behind the wealth of literature advocating international diversification from Grubel (1968) to the present day. Secondly, correlations tend to increase in times of large shocks to returns such as a stock market crash, e.g. see King and Wadhwani (1990), Longin and Solnik (1995) among others. Despite their undoubted importance, very little is known about what factors influence the underlying co-movement between two markets. Karolyi and Stulz (1996) observe that "the determinants of the levels and dynamics of these covariances have been little studied from an academic or from a practical perspective".

This paper makes an initial attempt to fill this void by focusing on the determinants of the level of cross-country stock market correlation using a gravity model. An understanding of the factors underpinning market correlations will have potentially important implications for equity portfolio selection as well as aiding comprehension of some financial puzzles, such as the observed home country bias in asset allocation.

Gravity models have grown in popularity in the past decade and have been applied in many different areas of economics and finance. They are predominantly empirical models that seek to explain the connection between markets. However, Anderson (1979), Bergstrand (1985), Feenstra, et al. (1998) and most recently Anderson and Van Wincoop (2001) have derived theoretical underpinnings. The basic idea behind the method is that geography matters. Variables associated with Physical geography, such as great circular distances and market size, along with those that emanate from 'Psychological geography' e.g. having a common border, having past colonial links, common language, etc enjoy great empirical success in explaining market links.

McCallum (1995) uses the methodology to explain Canadian regional trade patterns, while Engel and Rogers (1996) adapt the model to explain deviations in the law of one price for individual goods. Helliwell (1997) applies a gravity model to migration flows, while Brenton et al. (1999) use it to explain foreign direct investment flows. Their strongest results are that distances and borders are significant determinants of these flows. This is a potentially important explanation of the observed 'home bias' in trade patterns, which continues to be a puzzle in open economy macroeconomics (see Obstfeld and Rogoff (2000)). Anderson and van Wincoop (2001) cast some doubt on the strength of McCallum's border result. In their specification of the gravity model derived from microeconomic foundations the border has a relatively small, though still significant, impact on trade flows. More recent papers look at the effect of currency unions on trade patterns and international integration (Frankel and Rose (2000) and Rose and Engel (2000)).

Much of the aforementioned literature looks at connections between goods markets, or economies as a whole. Recently, gravity models have been applied to financial markets. Ex-ante, one would expect geography to matter less for asset markets. The ability of market participants to gather information and to trade instantaneously at low cost should render trader location irrelevant. With the advent of computer based trading systems, the growth of international equity flows has outpaced that of the goods and services sector. Consequently, it seems reasonable to expect that physical and psychological geographical variables should play less of a role in determining connections between financial markets. However, we know from the international portfolio diversification literature that portfolios are less internationally diversified than asset allocation models would predict. Given investors' reluctance to move funds abroad, and that this reluctance appears to increase as foreign asset markets become less familiar, geography may still play a role in determining financial market co-movements.

Portes and Rey (1999) in a treatment analogous to the trade flows application, look at equity flows between 14 countries. Even for asset trade, which is by definition weightless and transportation costs are not a factor, the distance variable is found to have significant explanatory power. This result suggests that the geography of information is important for equity flows. The distance effect is reduced, though still not eliminated when information transmission variables such as telephone call traffic and multinational bank branches are included in the specification.

Our analysis proceeds by first applying the standard gravity model, with distance and size measures, and the usual dummy variables such as colonial links, common language and common border. We then modify the approach to better capture asset market behaviour, incorporating explanatory variables that seek to capture ease of trading. We introduce a variable called 'Overlapping opening hours', which is simply the number of common opening hours of each pair of countries. Variables capturing market risk and industrial diversification are added. The two approaches are then contrasted, and the implications of the results for the connections between equity markets are discussed.

The paper proceeds as follows. In the next section, we review recent empirical literature on stock market correlation. Sections 3 and 4 refer to the standard gravity model and asset market model respectively. They present the models, describe the data and discuss our results. Finally, section 5 contains our concluding remarks.

2 STOCK MARKET CORRELATION

In the aftermath of the October 1987 stock market crash, more attention was afforded to stock market correlation and the related concept of equity return covariance. This new higher profile was deemed necessary when markets across the globe fell almost in unison. The goal of the literature was to answer why so many markets all experienced a dramatic adverse shock simultaneously. King and Wadhwani (1990) developed the idea of market contagion whereby shocks in a major market, such as the US, spills over into other markets. In their model, contagion occurs due to the non-synchronous trading hours and market participants trying to extrapolate information from price changes in earlier opening markets. This 'news' may be contaminated by market-specific information that should have no bearing on the domestic market being incorrectly incorporated into domestic prices. Contagion was found to increase with market volatility. They also provide empirical evidence that London stock prices tend to jump when the New York stock exchange opens, establishing a leader-follower pattern from bigger to smaller market. Later, King et al. (1994) show that little of stock market co-movement can be accounted for by observable economic factors and the majority is due to unobservable factors such as investor sentiment. Karolyi and Stulz (1996) analyse the co-movements of returns on Japanese and US stock markets. They fail to find a statistically significant relationship between asset returns and US macroeconomic announcements, shocks to the exchange rate, Treasury bill returns or industry effects. Ammer and Mei (1996) find that equity risk premia rather than fundamental variables account for most of the co-movements across national indices.

Longin and Solnik (1995) use a bivariate GARCH model to capture the conditional covariance structure. They find that correlations are unstable over time and covariances even more so. Furthermore, they provide empirical evidence that conditional correlations may be influenced by dividend yields and short-term interest rates. In a similar exercise, Ramchand and Susmel (1998) use a SW-ARCH model to show that correlations are both time- and state-dependent. Correlation tends to increase when markets become more volatile. Bodart and Reding (1999) also use a bivariate GARCH model to examine the impact of exchange rate variability on international correlation. Their main empirical result is that a reduction in exchange rate variability leads to an increase in international correlation of bond and stock market returns.

Groenen and Franses (2000) use a graphing technique to investigate stock market correlations and their evolution over time. They do not observe a world market portfolio but rather three clusters of markets that break down along geographical lines, namely Europe, Asia and US. These clusters have become more pronounced over time. Using clustering analysis, Heaney et al. (2000) report similar findings.

Most of this literature focuses on the time-varying (or dynamic) properties of stock market correlations. Little is known about the level of the co-movement at a point in time. This gravity model approach allows us to focus on these cross-sectional properties.

3 STANDARD GRAVITY MODEL

3.1 *The Model*

We begin our investigation of what drives stock market correlation by adopting a standard gravity model, akin to that found in the trade literature. The independent regressors are mainly geographical variables, though we replace country size with stock market capitalisation. Therefore the posited model is as follows

$$\begin{aligned} Corr_{ij} = \beta_0 + \beta_1 \ln(GCD)_{ij} + \beta_2 \ln(size_i * size_j) + \beta_3 border_{ij} \\ + \beta_4 lang_{ij} + \beta_5 col.links_{ij} + \beta_6 currency_{ij} + u_{ij}. \end{aligned} \tag{1}$$

The dependent variable is the unconditional correlation between stock markets *i* and *j*, GCD refers to the great circular distance between the main financial centres in countries *i* and *j*, market size is measured by the average market capitalisation in 1999 for that market. The variable labelled border is a dummy variable, which takes the value of one if the two countries share a common land border and zero otherwise. Language, colonial links and currency are similarly defined dummy variables.

3.2 *Data*

We use 1999 national stock market data for 27 countries (see Table 1 for a complete list of countries and their relative importance to the world portfolio). Figure 1 presents a map of global financial markets, with market capitalisation being represented by the size of the marker. We avoid the problem of computing spuriously low correlations by only selecting markets with a minimum market capitalisation. This threshold was arbitrarily chosen to be the Irish market and consequently this has the lowest capitalisation of all countries included. However, we do not claim to have an exhaustive list of markets bigger than the Irish exchange but our sample represents over 98% of the world market. The 27 markets give rise to 351 cross-country correlations. Stock market correlations are calculated from realised daily returns on each market. These returns along with size variables were computed using DATASTREAM constructed indices.

Information for the geographical variables was gathered from various websites and, in particular, the CIA World Fact Book. Websites of individual stock markets provided a great deal of information. The great circular distance is computed between the main financial centres, rather than country capitals. As emphasised by Figure 1, physical distance between markets is much larger in the Far East than for European markets.

As outlined above, we include a number of dummy variables in our model. The border dummy is simply a signal of whether there is a common (physical) border between each pair of countries. Countries connected by a bridge (Denmark and Sweden) or tunnel (France and UK) or those separated by a narrow strait of water (Malaysia and Singapore) are considered to have a border. The common currency dummy shows that there are two main currency blocks in our sample. The larger of these is the Euro zone, which accounts for nine of the financial markets in our sample. The other being the US-Mexico-Hong Kong foreign exchange agreement whereby the currencies of the two smaller partners are linked to the US dollar. Colonial links refer to historic linkages between countries with the most important of these being the group of "Common Wealth" countries. We also consider that South Africa has links with Holland. For the language dummy, we have ten countries that use English as their main language. Spain and Mexico share a common language, as do Portugal and Brazil.

3.3 *Results*

We estimate the standard gravity model, as specified in equation (1), and present our results in Table 2. The standard errors have been corrected for the presence of heteroscedasticity.[1]

TABLE 2
RESULTS OF STANDARD MODEL

	β_0	β_1	β_2	β_3	β_4	β_5	β_6
Estimate	0.38	-0.099	0.028	0.07	-0.011	-0.01	0.11
t-statistic	2.83	10.7	7.44	1.99	0.43	0.14	4.40
$R^2 = 0.59$							

[1] In principle, there may be a problem with using correlation as our dependent variable since by definition it can only take values between –1 and 1. This may be overcome by using the Fisher A-Z transformation to construct a variable, z=ln (1+corr)-ln (1-corr). Using this constructed variable, we find that exactly the same variables are statistically significant. For ease of interpretation, we revert to the unconditional correlation and correct for the presence of heteroscedasticity.

The results of the standard model are supportive of our approach, suggesting that our gravity model has some explanatory power over cross-country equity return correlation. All of the estimated coefficients are statistically significantly different from zero at the 5% level with the exception of those on the language and colonial links dummies. These are unsurprising given that most developed financial markets are comfortable with using English and of course, there is no real reason to expect that colonial links should play a role in the determination of equity price co-movement.

More surprising, however, is the strong significance of some of the other variables. In particular, Great Circular Distance (GCD) appears to be a key determinant of equity correlation, mirroring the results of Portes and Rey (1999) for equity flows. Given the negative coefficient, the greater the distance between two markets, the lower the correlation. Another related variable is the border dummy, which exerts a positive and significant impact on the level of the correlation. This means that stock markets in close proximity move together. This finding is consistent with Groenen and Franses (2000) who observe clusters of markets moving together which are broadly divided along geographical lines and Heaney et al. (2000) who suggest that stock markets cluster on a regional basis.

These geographical variables may reveal important insights into asset allocation and in particular the lack of potentially beneficial portfolio diversification across international markets. Many authors have been concerned with explaining this puzzle in portfolio selection. One potential explanation for this apparent “home bias” is that there is an asymmetry of information between domestic and foreign investors. In our analysis, these variables may be acting as a proxy for informational asymmetries. Portes and Rey (1999) offer a similar explanation in their study on equity flows. The inability of investors to gather or process information from “far-away” financial centres leads to portfolios that are concentrated in home or nearby markets. This regional behaviour among market participants will lead to stronger correlation between nearby markets. Hence, contagion effects between neighbouring countries may be stronger. Merton (1987) argues that investors are most likely to invest in securities that they are familiar with. Kang and Stulz (1997) support this argument when they observe that inward foreign investment in Japanese stocks is primarily concentrated in large domestic companies that have a higher international profile. Frankel and Schmuckler (1996) provide empirical evidence that it was Mexican investors and not “fickle foreigners” who fled the markets and precipitated the Mexican crisis of 1994.

Alternatively, these geographical variables may capture investor sentiment to which King et al. (1994) attribute a key role in determining asset market co-movements. French and Poterba (1991) suggest that home bias could result from investors feeling safer with domestic assets and feeling more optimistic than foreign investors about the prospects of domestic securities. The former argument is given credence by Tversky and Heath (1991) who present evidence that households perceive an unfamiliar gamble to have greater risk than a familiar one, even when both gambles have identical probability distributions. Also Schiller et al. (1991) present survey evidence consistent with the fact that investors are often more optimistic about the domestic market than foreign markets.

Correlation and size exhibit a positive and statistically significant relationship, i.e. the larger the markets, the more correlated they are. Larger markets being more liquid and displaying more price movement than smaller counterparts may potentially explain this. Smaller or thinly traded markets may not react as quickly to relevant information because some stocks may be traded infrequently. Larger markets may also be more diversified across industrial sectors and consequently are influenced by more common 'news'. Another possible explanation may be that the larger markets are driving this result. However, restricting the sample to 'small' markets (those with a market capitalisation less than Canada) and repeating our estimation, confirms that market size is a significant determinant of correlation and that the result is just as strong for our sample of small markets as for the whole set.

Finally, having a common currency also increases correlation. This may be due to high aversion to foreign exchange risk or indeed it may be further evidence of asymmetric information, this time with regard to currency price expectations. Bodart and Reding (1999) find that exchange rate variability exerts an influence on asset market correlation, though this result is more pronounced for bond rather than stock markets. An alternative explanation is that our common currency blocks are characterised by having trade agreements that have been shown to be an important source of stock market co-movement by Heaney et al. (2000).

4 ASSET MARKET MODEL

4.1 *The Model*

Despite the encouraging result of the standard model, we propose an alternative, the asset market model, which is adapted to include other variables that may be more associated with financial markets. Some of these are geographical in nature and others more financially oriented. Our main innovation is to include a measure of trading synchronicity, namely ‘Overlapping opening hours’. We also incorporate a measure of risk, a variable that captures similarities in industrial composition and modify the colonial links variable so as to capture the effects of corporate governance on inward investment. The full model is as follows

$$\begin{aligned} \boldsymbol{Corr_{ij}} &= \beta_0 + \beta_1 \ln(\boldsymbol{GCD})_{ij} + \beta_2 \boldsymbol{OLOH}_{ij} + \beta_3 \ln(\boldsymbol{size}_i * \boldsymbol{size}_j) + \beta_4 \boldsymbol{Ind}_{ij} \\ &+ \beta_5 \boldsymbol{conc}_{ij} + \beta_6 \boldsymbol{border}_{ij} + \beta_7 \boldsymbol{lang}_{ij} + \beta_8 (\boldsymbol{law}_i / \boldsymbol{law}_j) + \beta_9 \boldsymbol{currency}_{ij} + \boldsymbol{u}_{ij}. \end{aligned} \tag{2}$$

All variables that appeared in the standard model are defined as before, so we only concentrate on the new variables. Our measure of synchronicity, *OLOH,* is simply the number of overlapping opening hours between each pair of markets. Given the geographical nature of this variable, you might expect it to be closely related to the distance measure, but they have a relatively low correlation. This is due to the fact that cities that are far apart may still be in the same time zone, e.g. London and Johannesburg. This is further underlined by some markets (mostly Far Eastern) having morning and afternoon trading sessions, reducing the number of hours of common trading, despite some of these markets being geographically close. King and Wadhwani (1990), provide both a theoretical and empirical underpinning for the inclusion of overlapping opening hours. The important feature of their model is whether or not markets are open at the same time rather than the number of common trading hours. The coefficient on this variable should be able to give us some insight into market participant behaviour. For example, a positive sign may be indicative of markets reacting to global news or indeed market contagion, while a negative sign may be supportive of the view that trade causes noise in the return process.

The industrial composition of a market may be an important source of co-movement. For example, you may expect Germany (a market with many Industrial stocks) to be more highly correlated with another market in which industrial stocks are dominant, such as Taiwan, rather than its European neighbours of Denmark and UK where service and financial stocks are more important. Our measure, *Ind*, is a (crude, yet simple) 1/0 dummy variable, which takes the value of 1 if two markets share a common largest industrial sector or if both have a common sector that accounts for at least 25% of the index value, and 0 otherwise.

Given that much of financial economics is founded on the principle of a risk-return trade-off, it would also seem appropriate to include some measure of stock market risk. It is not as obvious as one might think to choose an appropriate proxy for risk given that the standard measures of standard deviation, variance and beta are all related to our dependent variable. Bearing this in mind, we have opted for a simple market concentration measure. The idea being that poorly diversified markets should be more risky than broad based indices. C*onc* is the proportion of the market accounted for by the 5 largest companies.

The results of our standard model show that colonial links play no role in the determination of international stock market correlation. However, one legacy remaining from colonial times is the influence on current law practices and more importantly for our study, the protections afforded to international investors under these regimes. La Porta et al. (1998) show that there are four major families of law, which influence corporate governance. The investment climates nurtured by these can vary quite considerably.[2]

4.2 *Data*

Variables appearing in the previous model are constructed as before. Data on overlapping opening hours was collected from the websites of the individual stock markets, while the data required to construct the Industrial sector dummy (see Table 3) and the concentration ratios were sourced from Datastream. Our law variable is constructed from data presented in Table 5 of La Porta et al. (1998). They present an index for each of five measures of law enforcement (efficiency of judicial system; rule of law; corruption; risk of expropriation; and risk of contract repudiation) that are designed to measure the friendliness of a market to inward investors. From these measures, we construct an equally-weighted index of the corporate governance climate that exists in each jurisdiction (details are supplied in Table 4). The index values range from 0 (adverse investment conditions) to 10 (very favourable conditions). Switzerland has the highest score, and the Scandinavian countries as well as the traditional markets do well. On the other hand, Mexico, India and South Africa fare worst and as such are regimes that add to the overall investment risk.

4.3 *Results*

Results for this model (with standard errors corrected for the presence of heteroscedasticity) are presented in Table 5. Panel A contains the results for equation (2), while a more concise version is given in Panel B (i.e. we drop the insignificant determinants).

[2] We are grateful to Peter Spencer for bringing our attention to this strand of literature.

TABLE 5
RESULTS OF THE ASSET MARKET MODEL

Panel A										
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9
Estimate	-1.19	0.004	0.04	0.045	0.035	0.43	0.125	-0.01	0.07	0.02
t- statistic	8.9	0.49	14.2	13.2	3.38	7.07	4.3	0.2	2.8	0.95
	$R^2 = 0.75$									
Panel B										
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9
Estimate	-1.15		0.04	0.045	0.035	0.44	0.125		0.07	
t- statistic	11.7		22.8	13.1	3.43	7.66	4.7		2.78	
	$R^2 = 0.75$									

Again, there is empirical evidence to support our model, with all variables being statistically significant at conventional levels with the exception of distance, language and the currency dummy variable. The geographical variables have different degrees of success in explaining cross-country stock market co-movement. Great circular distance is no longer a significant determinant of stock market correlation when we add the number of overlapping opening hours to the model. The border dummy variable, however, retains its positive and statistically significant relationship with the level of correlation. Once more, this is most likely to be capturing investor sentiment or informational asymmetries.

Our hypothesis that overlapping opening hours may be an important determinant of equity return correlation is strongly supported by the data. The more hours of common trading the greater the degree of equity price co-movement. For an advocate of the efficient market hypothesis, this may indicate that markets are reacting to ‘global news’ simultaneously (or at least with shorter time lags) and immediate price changes lead to increased correlation. Alternatively, it could be evidence of stock market contagion or herd behaviour among market participants. King and Wadhwani (1990) provide evidence of contagion between London and New York stock markets that results from non-synchronous trading. This contagion occurs due to investors' attempts to infer information from price changes in the other market. Of course, another more practical explanation may be that traders just find it easier to conduct business with other financial market participants who are active at the same time. Common opening hours may facilitate the dissemination of information among investors, thereby reducing the aforementioned asymmetries. Consequently, two of our geographical variables - overlapping opening hours and the common border dummy - contain important explanatory power over cross-country equity co-movements.

Re-estimating our model with weekly (as opposed to daily) return correlations as the dependent variable strengthens the hypothesis that the geographical variables are acting as a proxy for informational asymmetries. The overlapping opening hours continues to be a significant explanatory variable. This leads us to believe that differences in investors' information rather than ease of trading are driving this result.

The market capitalisation variable follows the same pattern as in the standard model and therefore the same interpretation is offered. The dummy variable that captures similarities in industrial composition is also highly statistically significant. However, the estimated coefficient of 0.035 is quite low, but consistent with the studies of Heston and Rouwenhorst (1994, 1995), Rouwenhorst (1999) and Griffin and Karolyi (1998). These studies show that industrial composition accounts for a low proportion of stock return covariance, about 4% in most studies.

The risk measure is highly statistically significant and has a positive relationship with cross-country equity correlation. A priori, one might expect that this concentration variable would be negatively related to our dependent variable. Since a high concentration ratio is indicative of a poorly diversified market, it is reasonable to assume that information relevant to that sector would tend to cause greater price movement in this financial centre than in a large diversified exchange. This would give rise to low levels of co-movement. Two poorly diversified markets that specialise in different industries should also have low correlation. However, closer inspection of the individual stock markets reveals that it is the importance of the Telecommunications sector that is driving our result. Figure 2 shows the proportion of market capitalisation of each index that is accounted for by telecom stocks as at December 31, 1999.[3] Almost half of the markets in our sample have at least 20% of the index in telecom stocks. Consequently, 'news' relevant to this sector appears to be causing the observed positive co-movement.

Also, our measure of corporate governance turns out to be a significant determinant of stock market correlation. This variable is entered as a ratio. The positive coefficient tells us that the closer markets are in terms of 'investor friendliness' then the more likely they are to move together. Of course, we would expect two 'highly protected' markets to follow this pattern. However, in the case of two 'poorly protected' markets, this may be indicative of market segmentation. According to Bartram and Dufey (2001) market segmentation is "caused by barriers that are difficult for investors to overcome, such as legal restrictions on international investment….". Without explicit bans on inward investment, market segmentation may arise due to the lack of appropriate investor protections in certain countries. This could be reflected in little (or slower) movement in asset prices in these indices due to a lack of international investment. Two such markets would also have a ratio close to unity. Pairs of markets with a ratio far from one are likely

[3] These concentration ratios also contain some "high-tech" stocks which specialise in manufacturing telecommunications equipment.

to involve one markets that attracts large inward financial investment and consequently displays more price movement and a more segmented market. It is reasonable to expect such markets to have lower correlation.

Finally, our currency variable is insignificantly different from zero in this specification of the model. It's likely that in the standard model its significance was being driven by a Euro zone effect, which is now being more appropriately accounted for by overlapping opening hours. This effect is likely to be strengthened given that many European markets have synchronised their markets. Its lack of significance is consistent with other studies (e.g. Bodart and Reding (1999), Eun and Resnick (1988)) that show currency risk is a more important consideration for bond rather than equity portfolio managers. Currency risk generally accounts for a small proportion of total equity risk.

The asset market model is obviously the better model and this is confirmed by formal statistical tests. However, geographical variables still matter with overlapping opening hours and the border effect significant determinants of stock market co-movement. The fact that the inclusion of our synchronicity measure leads to the exclusion of the distance variable does not remove the validity of the gravity model approach. If anything, it may help us better understand where these geographical influences are coming from.

5 CONCLUSION

Geographical variables have long been known to explain linkages between goods markets. Our analysis shows that this result is also applicable to financial asset markets. Gravity models can explain cross-country equity return correlation. We find that measures of stock market proximity as well as sharing a common border are important explanatory variables for stock market correlation. These geographical measures may be acting as a proxy for informational asymmetries across the investment community. This finding has important implications for the international diversification (or home bias) puzzle as it gives more credibility to the proponents of asymmetric information as a potential explanation. Investors may be more comfortable with portfolios that are concentrated in their region, hence amplifying the effects of an adverse shock in that area. Overlapping opening hours could be capturing many effects, from markets reacting to global news to market contagion to the ease of trading with another market participant at another location.

We also find that more conventional financial variables such as market size and risk (level of concentration) influence cross-country correlation. In particular, larger markets tend to be more correlated. This result may be due, at least in part, to market liquidity with larger, more liquid markets exhibiting stronger co-movements than thinly traded markets. Such markets will react more quickly and to a greater range of information than a thin market dominated by one sector and consequently exhibits higher correlation. Our risk measure tells us that more concentrated markets tend to move together but this result may be driven by the global importance of telecom stocks.

The industrial composition of markets also helps to explain stock market correlation. This is intuitive, as we would expect markets with a common dominant industry to exhibit higher co-movement. Likewise, the colonial past seems to have left an important legacy in terms of its influence upon the legal regimes and in particular the laws of corporate governance in various countries. La Porta et al. (1998) document this effect and our model finds empirical support for its significance in determining stock price co-movements.

The main contribution of this paper is to show that results found in the literature explaining goods trade extend to financial asset markets. Even for financial markets, geography and borders matter. Market participant behaviour and informational asymmetries may explain the large and statistically significant influence exerted on the level of stock market co-movement by these variables.

TABLE 1
DISTRIBUTION OF COUNTRIES AND THEIR RELATIVE IMPORTANCE
TO WORLD MARKET PORTFOLIO

Country	Proportion of World Market (%)
USA	47.2
Japan	13.0
UK	9.3
Germany	4.1
France	3.8
Switzerland	2.6
Holland	2.4
Italy	2.1
Canada	2.1
Hong Kong	1.5
Australia	1.4
Spain	1.2
Sweden	1.0
Taiwan	0.9
Finland	0.7
Korea	0.6
Belgium	0.6
Brazil	0.5
Singapore	0.5
South Africa	0.5
Mexico	0.4
India	0.4
Greece	0.3
Denmark	0.3
Malaysia	0.3
Portugal	0.2
Ireland	0.2
Total	**98.1**

Notes: All data contained in this table were sourced from Datastream.

TABLE 3

IMPORTANCE OF INDUSTRIAL SECTORS TO NATIONAL INDICES

Country	Industrial	Financial	Services	Consumer	Utils	Itech	Resor
USA	0.11	0.17	**0.23**	0.19	0.03	0.22	0.04
Japan	0.19	0.18	**0.28**	0.20	0.03	0.11	0.01
UK	0.08	**0.26**	**0.31**	0.17	0.05	0.02	0.12
Germany	**0.26**	**0.26**	0.24	0.18	0.02	0.04	0.00
France	0.23	0.16	**0.26**	0.19	0.00	0.08	0.09
Switzerland	0.11	**0.32**	0.07	**0.49**	0.01	0.00	0.00
Holland	0.10	**0.33**	0.20	0.13	0.00	0.03	0.21
Italy	0.05	**0.41**	0.32	0.07	0.04	0.00	0.10
Canada	0.15	**0.22**	0.17	0.09	0.04	0.20	0.13
Hong Kong	0.19	**0.49**	**0.24**	0.01	0.06	0.01	0.00
Australia	0.06	**0.32**	**0.42**	0.06	0.01	0.00	0.13
Spain	0.10	**0.36**	0.24	0.03	0.20	0.00	0.07
Sweden	0.24	0.19	0.15	0.10	0.02	**0.29**	0.02
Taiwan	**0.47**	**0.25**	0.03	0.06	0.00	0.19	0.00
Finland	0.14	0.05	0.14	0.03	0.00	**0.61**	0.02
Korea	**0.36**	0.20	0.24	0.04	0.12	0.02	0.02
Belgium	0.14	**0.44**	0.11	0.06	0.24	0.01	0.00
Brazil	0.06	0.17	**0.42**	0.04	0.07	0.00	0.24
Singapore	0.16	**0.39**	**0.42**	0.03	0.00	0.00	0.00
South Africa	0.13	**0.36**	0.14	0.06	0.00	0.03	0.27
Mexico	0.19	0.09	**0.60**	0.12	0.00	0.00	0.00
India	**0.30**	0.06	0.08	**0.26**	0.02	0.15	0.13
Greece	0.09	**0.43**	**0.28**	0.08	0.00	0.07	0.05
Denmark	0.08	0.21	**0.52**	0.19	0.00	0.00	0.00
Malaysia	0.19	0.23	**0.28**	0.15	0.14	0.00	0.01
Portugal	0.11	**0.36**	**0.35**	0.01	0.17	0.00	0.00
Ireland	0.21	**0.47**	0.07	0.24	0.00	0.00	0.01

Notes: This table gives the relative importance of 7 industrial sectors (Industrial, Financial, Services, Consumer Goods, Utilities, Information Technology and Resources) in each of the 27 markets in the analysis. Numbers in bold denote the dominant sector in each index along with sectors that account for at least 25% of the market. All data contained in this table were sourced from Datastream.

TABLE 4

INDEX OF CORPORATE GOVERNANCE FOR 27 COUNTRIES

Country	Efficiency of the Judicial System	Rule of Law	Corruption	Risk of Expropriation	Risk of Contract Repudiation	Index
USA	10.00	10.00	8.63	9.98	9.00	9.52
Japan	10.00	8.98	8.52	9.67	9.69	9.37
UK	10.00	8.57	9.10	9.71	9.63	9.40
Germany	9.00	9.23	8.93	9.90	9.77	9.37
France	8.00	8.98	9.05	9.65	9.19	8.97
Switzerland	10.00	10.00	10.00	9.98	9.98	9.99
Holland	10.00	10.00	10.00	9.98	9.35	9.87
Italy	6.75	8.33	6.13	9.35	9.17	7.95
Canada	9.25	10.00	10.00	9.67	8.71	9.53
Hong Kong	10.00	8.22	8.52	8.29	8.82	8.77
Australia	10.00	10.00	8.52	9.27	8.71	9.30
Spain	6.25	7.80	7.38	9.52	8.40	7.87
Sweden	10.00	10.00	10.00	9.40	9.58	9.80
Taiwan	6.75	8.52	6.85	9.12	9.16	8.08
Finland	10.00	10.00	10.00	9.67	9.15	9.76
Korea	6.00	5.35	5.30	8.31	8.59	6.71
Belgium	9.50	10.00	8.82	9.63	9.48	9.49
Brazil	5.75	6.32	6.32	7.62	6.30	6.46
Singapore	10.00	8.57	8.22	9.30	8.86	8.99
S. Africa	6.00	4.42	8.92	6.88	7.27	6.70
Mexico	6.00	5.35	4.77	7.29	6.55	5.99
India	8.00	4.17	4.58	7.75	6.11	6.12
Greece	7.00	6.18	7.27	7.12	6.62	6.84
Denmark	10.00	10.00	10.00	9.67	9.31	9.80
Malaysia	9.00	6.78	7.38	7.95	7.43	7.71
Portugal	5.50	8.68	7.38	8.90	8.57	7.81
Ireland	8.75	7.80	8.52	9.67	8.96	8.74

Notes: Numbers in Columns 2-6 are taken from Table 5 of La Porta et al. (1998). The index (column 7) is an equally-weighted average of these. The numbers range from 0 to 10, with 0 representing the worst investor conditions, i.e. poor judicial system, high corruption etc, while 10 denotes the most favourable conditions.

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